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RESEARCH NOTE

3-D Virtual Worlds in Education: Applications, Benefits, Issues, and Opportunities

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ABSTRACT

Three-dimensional virtual world environments are providing new opportunities to develop engaging, interactive experiences in education. These virtual worlds are unique in that they allow individuals to interact with others through their avatars and with objects in the environment, and can create experiences that are not necessarily possible in the real world. To assess the impact that these virtual worlds are currently having on education, a literature review is conducted to identify current applications, benefits being realized, as well as issues faced. Based on this review, virtual world capabilities, experiences, and factors associated with educational opportunities are presented as well as gaps in meeting pedagogical objectives. Practical and research implications are then addressed. Virtual worlds are proving to provide unique educational experiences, with its potential only at the cusp of being explored.

Keywords: *Active Worlds; Second Life; virtual education; virtual worlds*

INTRODUCTION

Engagement, interactivity, collaboration, experimentation, and idea generation – Achieving these common objectives has been an on-going challenge for many in the field of education, and has become more complicated and challenging as courses move to on-line formats. In trying to achieve enhancements in these different aspects, many instructors have looked to technologies such as wikis and blogs (Guru and Siau, 2008) to discussion forums on Blackboard as a means to achieve these objectives. However, there are limitations with these technologies.

One particular technology that presents new opportunities to achieving these objectives is three-dimensional (3-D) virtual world technology which provides a common space for individuals to interact and create an environment that suits their needs. One may establish replications of reality in this virtual space for individuals to explore or interact with. Alternatively, entirely new spaces can be created and individuals allowed to generate ideas and experiment with them. Whatever the purpose, the nature of the virtual reality is such that students have the potential to become engaged

in a simulated activity and collaborate in a dispersed setting that more closely replicates the advantages of being face-to-face.

In addition, changes in educational paradigms are creating a need for new technologies to support new learning environments. Dickey (2005a) cites that creating *interactive* learning environments is a current trend being supported by the increasing shift towards constructivism. The paradigm advocates that knowledge is *constructed* and learners need to be more engaged in the learning process. Therefore, environments that are conducive to learners being able to manipulate and explore are more conducive to constructivist activities and learning. Also, Barab et al. (2000) cite that many learning environments are becoming more collaborative in nature. Therefore, technology incorporated into a curriculum should engage students in the learning process, allow students to experiment and explore so as to construct their own knowledge base, and provide an adequate platform for rich communication and cooperation to take place.

3-D virtual world environments may prove to enhance existing technologies' capabilities to better achieve these goals. The environments offer abilities to communicate and collaborate with others in a shared virtual space that is created by the users and foster potential for many educational and cooperative activities. Typically, the virtual environments are created by the users. These capabilities afford new opportunities for creativity to abound and for idea generation and experimentation to flourish.

Accounts of educational applications of virtual worlds provide insights into various opportunities that exist and are being realized, along with issues that have been encountered. This article addresses these applications and opportunities by focusing on 3-D virtual world environments in educational contexts. Specifically, this article reviews the literature that addresses current applications, benefits, and issues of virtual worlds in education, then summarizes opportunities and gaps of these virtual worlds for consideration in education, and highlights implications for both practice and research.

3-D VIRTUAL WORLDS IN EDUCATION

Educational institutions continually explore new opportunities to bring the classroom online as technology continues to grow in sophistication and capabilities (Erickson and Siau, 2003). Some pursue this endeavor to create greater opportunities to reach students through distance education programs. However, some have extended this concept of using Internet-based technologies to teach by creating more sophisticated virtual realities or virtual worlds to expand on the interaction that takes place among students as well as with their instructors. Bryson (1996) has defined virtual reality as "the use of computers and human-computer interfaces to create the effect of a three-dimensional world containing interactive objects with a strong sense of three-dimensional presence" (p. 62). He notes three important attributes of virtual reality environments: computer-generated, three-dimensional, and interactive. Also, he emphasizes that virtual reality environments entail creating an effect of interacting with things and are characterized by the interface. Other features and characterizations of 3-D virtual worlds include the illusion of 3-D space that allows real-time interaction/interactive capabilities, avatars that are digital representations of users, chat tools facilitating communication, first person viewpoints, navigation freedom, and abilities of participants to share space as well as time and to design their own spaces (Dickey, 2005a, 2005b; Mikropoulos, 2001; Ondrejka, 2008).

These virtual worlds extend the functionality of other technologies by generating more dynamic environments in that individuals can participate or view objects, simulations, or others in a 3-D space. Mennecke, McNeill, Ganis, and Roche (2008) suggest that the popularity of these 3-D virtual environments has been increasing because of "stunning visuals, animations, role playing opportunities, and

social communities" as well as "the interaction that users experience" (p. 373). Engagement is being enhanced by the nature of a shared environment.

For instance, Dickey (2005b) found from her case studies of educational institutions (one using the Active World environment for an undergraduate business computing course and the other an object modeling course) that these 3-D virtual worlds afford various opportunities for students and instructors. In the business computing course, students utilized the virtual world to complete and submit assignments, review their grades, locate web-linked resources, collaborate with other students, and communicate by way of a chat tool. In the object modeling course, the instructor used chat tools to promote discussion, and presented examples of 3-D objects.

The opportunities realized included promoting collaborative and cooperative learning (Siau, 2003), self-defining the learning context, creating interactive experiences with materials or models that may not be replicable in a traditional classroom (Siau, et al., 2006), and providing engaging, constructivist activities. Students indicated that they felt a sense of presence in the environment, while instructors indicated that a significant drop in attrition rates occurred (Dickey, 2005b). Instructors also noted that the environment advocated constructivist approaches in that it provided collaboration opportunities, real-time communication, as well as a visual learning environment. The researcher noted that the sense of anonymity promoted more daring interactions among students/avatars.

Virtual worlds have also been designed to create simulations of real world phenomena to provide an environment for experiential learning and training. An example is the simulation of a toddler's initial cognitive experience when joining a daycare to improve caregiver's awareness of these experiences (Passig, Klein, & Noyman, 2001).

Also, Mantovani, Castelnuovo, Gaggioli, and Riva (2003) cite specific health care related learning applications that include creating simulations for emergency training, mental health training (e.g., experience hallucinations of schizophrenia patients), brain and body interactivity training, and telesurgical training (focused on teaching certain skill sets). The authors suggest that learning environment and individual factors such as the material to be learned, characteristics of learners, as well as the learning and interactive experience can influence the process of learning and the resulting outcomes.

Various 3-D virtual world environments utilized in educational contexts exist today to support these endeavors. For example, Active Worlds Educational Universe, launched in 1999, is a browser-based virtual environment that consists of user-created 3-D worlds inhabited by avatars (Dickey, 2005a; Peterson, 2006). Avatars are digital personas used to represent a person's identity in a virtual world environment (Conway, 2007). An avatar is typically a caricature, a full body, or can be just a head shot. In Active Worlds, avatars can be customized if the user is registered, otherwise users are restricted to standardized avatars that can walk, run, slide, and fly throughout the virtual world (Dickey, 2005a; Peterson, 2006). Users can interact within the environment or access Web pages. Sensors or triggers can be placed throughout the world such that when an avatar encounters one, pre-specified actions will occur (e.g., transporting to a new location).

Similarly, Adobe Atmosphere (established in 2001) is a 3-D virtual world environment that allows avatars to navigate and interact with one another (Dickey, 2005a). Worlds are created by users and can be linked together. Another example of virtual world environments that is increasing in popularity is Second Life. Second Life was launched in 2003 by Linden Lab (Joly, 2007). Individuals are able to create avatars, also called residents of Second Life, that can be navigated to explore the environment, socialize with other avatars, participate in activities, and produce and trade items and services. Avatars don't necessarily have to be human, they can range from animal forms to a "giant bowl of Jell-O" (Graves, 2008, p. 49).

Nearly 12 million unique avatar accounts exist in early 2008 in Second Life (Mennecke et al., 2008). Also, Second Life provides textual, visual, and auditory communication channels (Junglas, Johnson, Steel, Abraham, & Loughlin, 2007). Ondrejka (2008) and Goral (2008) clarify that Second Life is not a game, but has a plethora of opportunities being pursued by various educational and research communities. Schultze, Hiltz, Nardi, Rennecker, and Stucky (2008) indicate that over 100 universities have conducted classes or sessions in Second Life. Also, Second Life has created a new avenue for business opportunities. The Linden Dollar currency can be exchanged for U.S. dollars and objects can be set to "copy" or as "for sale" to facilitate economic exchange (Jennings & Collins, 2007).

Second Life is unique in that the environment is created by its users. Linden Lab offers the foundational and communication tools for residents to build their own unique worlds and experiences. Educational institutions can purchase islands in Second Life for around US$700 per region (Second Life, 2008).

According to the Second Life website (www.secondlife.com), Second Life functionality that supports educational endeavors includes (Second Life, 2008):

- Conducting distance education courses
- Simulations and interactive content
- Training seminars
- Collaborative work efforts
- Studies in new media
- Security through private island purchases
- Skill practice or opportunities to experiment with new ideas

Hence, various applications of 3-D virtual world environments in an educational context are possible and are discussed below.

Current Applications

Educational applications of 3-D virtual world environments continue to grow and are capitalizing on the unique capabilities that these virtual environments can offer. These capabilities provide avenues for novel expressions to emerge, a new means to "participate" in classes, as well as new ways to reach wider audiences. Rich forms of communications provide new venues for class or group discussions.

For example, capabilities associated with Second Life include (Jennings & Collins, 2007):

- Accenting site with logos, maps, welcome signs, and various forms of greetings
- Offering promotional materials to visitors (e.g., free t-shirts for avatar)
- Sidewalks, pathways/footpaths, bridges, and elevators for avatar to navigate within site
- Links to other Internet websites and teleports to other Second Life locations
- Communication tools – text or audio
- Space for classrooms, auditoriums (includes podium, video screen, chalkboard, and seating for avatars), libraries, theater, offices (includes chairs and desk), research labs, sandbox (for building), role-playing, student projects, assignment distribution and submission, apartments/housing, art galleries, visitor centers, resource centers, meetings for campus organizations, and socializing (e.g., bars, restaurants, dance clubs, beaches, gardens, game rooms, coffee shops)
- Creating sense of openness (e.g., buildings with mesh ceilings and no walls, bubbles floating in the air, pane glass windows looking at ocean/patios/vegetation)
- Replication of real-world environment and building connections with real-world (e.g., animal life, natural vegetation, historic buildings, campus layout)
- Social accommodations (e.g., offering beverages, listening to radio, vending machines)
- Simulations of events, games, etc.

In regards to the structure that shapes these virtual worlds in educational applications, Jennings and Collins (2007) have noted

that some institutions are choosing to develop a "reflective virtual campus environment" or developing a replication of its physical campus and orchestrating connections to the real-world, while others are developing an "operative virtual campus environment" or creating a virtual location that is unique from its physical campus and performing activities virtually (p. 184). Hence, the applications for higher education are various and they are provided in Table 1. These applications are categorized into three categories or types based on their purpose: (i) replicating reality and existing activities, (ii) developing novel spaces and conducting activities unique to the virtual world environment , (iii) those focusing on accomplishing both of the above.

Some instructors have chosen to hold classes fully through Second Life, while others are utilizing a hybrid method (Jennings & Collins, 2007). Richter, Anderson-Inman, and Frisbee (2007) identify five different types of learner engagement that are possible in Second Life: demonstrative, experiential, diagnostic, role play, and constructivist. For example, Schultze et al. (2008) suggest that students could participate in role-playing scenarios such as discussing an ethical dilemma and debating over the various perspectives that arise. All students could ask questions and vote. Therefore, applications and opportunities of Second Life in education continue to emerge, and with these developments certain benefits and issues have been identified.

Benefits

A variety of potential beneficial outcomes experienced when utilizing 3-D virtual worlds in an educational context have been cited. Benefits that were identified based on our review include conducting educational activities in a risk-free environment, enhancements in collaboration and communication, engaging learners, and being able to utilize an alternative space for conducting courses and associated tasks, explained as follows:

i. Conducting Activities in a Risk-free Environment

As noted previously, a variety of activities and tasks can be conducted in 3-D virtual worlds, and many of these can be carried out with less apprehension by the learner. For instance, some have cited the benefits of Second Life that include providing "a social laboratory where role-playing, simulations, exploration, and experimentation can be tried out in a relatively risk-free environment." (Graves, 2008, p. 50). Dickey (2005a) cites previous research demonstrating benefits of virtual environments including being able to experiment without concern for "real-world repercussions" and being able to "learn by doing." Ondrejka (2008) cites that some students have cited a greater level of comfort in asking questions, and are able to develop a sense of shared learning. Goral (2008) cites exploring new domains of interest and innovation as possibilities in Second Life. Students who are interested in on-line courses may be more attuned to those taught via avatars because it could provide opportunities to introduce more creativity into the classroom (Conway, 2007).

ii. Collaboration and Communication

Benefits of using 3-D virtual worlds in education include enhanced collaboration and communication capabilities. In research conducted invirtual world environments, the creation of an avatar increased the individual user's sense of telepresence or copresence, which has been suggested to improve communication, as well as social and educational experiences in virtual environments (Peterson, 2006). Active Worlds allows non-verbal communication cues and emotional states to be displayed by one's avatar in real-time, which extends the capabilities of technologies that are only text-based. According to Bronack, Reidl, and Tashner (2006) who utilize the AET Zone, a 3-D virtual world created with an Active Worlds Inc. universe server and developed for Appalachian State University, the

Table 1. Examples of educational applications in 3-D virtual environments for higher education

Organization	Application	Source
1. Replicating Reality – Utilizing Alternative Space for Existing Activities		
Appalachian State University and Clemson University	3-D virtual world created to improve online learning for master's degree students.	"ASU Partners", 2008
Ball State University – Middletown Island	Intellagirl conducts freshman English-composition class.	Foster, 2007b
Duke University's Fuqua School of Business	Partnering with ProtonMedia to create 3-D spaces for education or "telepresence portal."	"Bringing Virtual Worlds," 2008
INSEAD - France and Singapore	School/library is open-air building with auditorium seating 36. Clickable computer screens provide access to other web pages and library offers hot tea. Research lab provides notecards to describe research and request consent. Public space/beach provides clickable kiosks to obtain more information about INSEAD, space for reflecting and conversing, bar with drinks available, and listening to radio.	Jennings & Collins, 2007
Princeton University	Created island that includes lecture hall, art museum, and performance location.	Graves, 2008
2. Developing Novel Space – Conducting Activities Unique to Virtual World		
Immersive Education project - Boston College, Harvard University, Amherst College, Columbia University, Massachusetts Institute of Technology, Sweden's Royal Institute of Technology, Japan's University of Aizu, the Israeli Association of Grid Technologies, National Aeronautics and Space Administration (NASA), Sun Microsystems, the City of Boston, and the New Media Consortium	Created tours inside Egyptian tomb, created interactive lessons (Croquet and Project Wonderland), developed park and replica of Boston's subway system to tour city's neighborhoods, developed Restaurant Game to help waiters/waitresses acquire skills/training through simulations of restaurant experiences.	Foster, 2007a
Indiana University	Created a Virtual Solar System project for astronomy undergraduate course.	Barab et al., 2000
Lehigh Carbon Community College and adjunct at DeSales University (professor at both)	Professor created Literature Alive – provides guided tours of famous literary locations (e.g., Dante's Inferno).	Foster, 2007b
Vassar College – Vassar Island	Re-creation of Sistine Chapel – visitors can fly to ceiling or view tapestries designed for the walls.	Foster, 2007b

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Table 1. continued

3. Replicating Reality and Developing Novel Space		
Boise State University	EDTech island utilized for teaching educational games and providing students testing area (building own objects), includes information center, and condominium.	Goral, 2008
Bowling Green State, Ohio	Use virtual campus for teaching, research, office hours (space pods situated into mountain sides), exhibiting art and music, and presentations by guest speakers. In process of creating a writing center ran by graduate students.	Goral, 2008
Bradley University	Students have conducted analyses of avatar fans of musicians that conduct performances in Second Life, as well as other topics such as online hackers.	Foster, 2007b
Georgia Institute of Technology	Augmented Reality lab created software to associate actual physical spaces with virtual – creating ability to combine video feeds from the real world with Second Life avatars.	Goral, 2008
Johnson & Wales University	Created a Virtual Morocco in conjunction with Ministry of Tourism of Morocco. Includes monuments and opportunities to learn about Moroccan culture. Students created and developed plans and prototypes, and worked with individuals from other countries on project. Virtual BLAST (Balloon-borne Large-Aperture Submillimeter Telescope) brought attention to scientific ballooning projects by flying over the Second Life main grid and stopping to visit various educational and scientific locations. Entrepreneurship students create business plans and develop prototypes in Second Life.	Mason , 2007
Massachusetts Institute of Technology	75% of island dedicated to student projects, remainder replicates physical campus (including outdoor theater area). Avatars can address a crowd with a megaphone and determine average viewpoint by avatars moving to right or left of line on platform. Sponsored contest for students to design dormitories.	Foster, 2007b
Montclair State University	Use mountain sides for displaying syllabus and spheres for deadlines, Literature Alive spots include Willow Springs and encountering evil in Young Goodman Brown, and provide sun bathing area as well as covered deck near lake.	Foster, 2007b

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Table 1. continued

Ohio University or Ohio University Without Boundaries	Entry way provides historical information and historic replicas of campus (along with Standards and Privacy Statement). Locations include Welcome Center (video display of learning intiatives), Art and Music Center, Classroom and Meeting Center (with seating capacity of 25), Learning Center (displaying e-learning activities), Student Center (coffee shop, stage which includes microphone, pool tables, kiosk publicizing real-world entertainment activities, student video lounge, vending machines, and reading space), Featured Games (simulation of fast food restaurant – avatar selects food to learn nutritional value), Stocker Center and Sandbox (building objects by permission). Collaborated with The Princeton Review for SAT preparation.	Jennings & Collins, 2007; Goral, 2008
Simon Fraser University	Professor produced films for posting on YouTube and created cartoons for first-year calculus students.	Conway, 2007

benefits of education in virtual worlds include "a sense of presence, immediacy, movement, artifacts, and communications unavailable within traditional Internet-based learning environments" (p. 220). They also noted that they are able to have interactions with their students in "more fluid and natural ways" (p. 230), are allowing students to select their own paths of learning, resources, and activities, and are "encouraging cross-class collaboration" (p. 230). Their students have indicated that they have found the interactions with other students to be stimulating and the experience to be enriching. Dickey (2005a, 2005b) has also cited that the chat tools and communication capabilities in environments such as Active Worlds provide a platform for collaborative and cooperative learning, which is highly valued in the socio-constructivist paradigm.

Some have noted the ability to interact with individuals who are physically located throughout the world (Graves, 2008). Having the ability to create an avatar that is not only human in form but can be modeled to be almost identical to oneself can help to enhance on-line communication (Foster, 2007a). Goral (2008) cites the benefits of collaborating and interacting with others who are geographically dispersed, engaging with others in discussions of similar interests, and engaging in rich forms of communication. Chang Liu, director of Virtual Immersive Technologies and Arts for Learning Lab which is associated with Ohio University Without Boundaries, argues that Second Life is "a very rich form of communication, and the main task of education is communication." (Goral, 2008, p. 62). Also, Second Life has been cited as providing a culturally diverse experience and providing livelier communication in distance education courses (Foster, 2007b).

iii. Engagement

Increased engagement has also been associated with the use of 3-D virtual world environments in education. In research conducted by Mikropoulos (2001), brain activity was measured for tasks performed in real as well as virtual reality environments. Research findings demonstrated subjects were more attentive, responsive, and utilized less mental effort in the virtual world, demonstrating that knowledge transfer is possible (such that knowledge gained in one world can be transferred to the other world).

Mason (2007) cites students being more engaged in learning tasks and spending more time thinking and discussing the subject material, while Richter, Anderson-Inman, and Frisbee (2007) cites perceptions of immersion into another world and engaging in learning in the first person (which is more interactive and experiential). Second Life experiences can be created such that information is available when the learner needs and wants it (Ondrejka, 2008). Dickey (2005b) has also cited that allowing learners to interact with information in the first person facilitates constructivist-based learning activities, and that the user-extensible options in Active Worlds provide greater opportunity for learner engagement. Also, Dickey (2005a) has cited that previous research indicates that being able to interact with virtual objects may assist in developing a stronger conceptual understanding, depending on the content.

Using virtual worlds can increase enthusiasm for learning and introduces some to an experience (in virtual worlds) that they may have never realized (Foster, 2007b).

iv. Alternative Space for Instruction and Tasks

Some educational professionals see opportunities to conduct courses or related activities in places other than the classroom including visiting simulations of places that no longer exist in real life (Graves, 2008). One associate dean has even cited that these virtual campuses could be a back-up to the physical location in cases of natural disasters such as Katrina (Graves, 2008). Others, who are situated in more risky locations, find Second Life a safer venue to have undergraduates conduct field research projects (Foster, 2007b).

Conway (2007) suggests that teaching through an academic avatar that follows the traditional classroom instructional methods in a virtual environment can provide the instructor opportunities to spend more time on spontaneous and productive interactions through groupwork or class discussions in the real-world classroom by freeing up precious time. Experiential learning programs can be designed such that relevant skills can be practiced and acquired (Mason, 2007). Dickey (2005a) has cited the ability to personalize one's learning space.

iv. Visualization for Difficult Content

Some subject-matter is more difficult to learn through material that is presented in a static format. For example, Barab et al. (2000) indicated that concepts such as "lines of nodes" and the variety of scales and sizes are typically disregarded in introductory astronomy courses because of the difficulty in understanding these concepts which are dynamic and 3-D in nature. Hence, their use of a 3-D virtual environment allowed students to more easily grasp these concepts.

Hence, virtual worlds present their own unique set of opportunities, but with that, their own unique issues.

Issues

Applications of virtual environments in an educational context pose unique issues. These issues include identifying value-added educational applications; being able to read people's natural physical cues; technological issues; costs; behavioral, health and safety issues; and user adoption. Issues cited for virtual world environments in education are discussed as follows:

i. Appropriate Value-added Educational Applications

Identifying appropriate value-added educational content and activities in which 3-D virtual worlds can be effectively utilized has been cited as an issue. Mantovani, Castelnuovo, Gaggioli, and Riva (2003) indicate two challenges to utilizing virtual worlds in education: 1) determining situations in which virtual world learning presents value beyond what traditional education can provide, and 2) determining how to effectively utilize and adapt these worlds to

support learning. Although 3-D virtual worlds may be utilized to conduct educational games, some indicate that promoting games in learning environments is degrading to education (Foster, 2007a). Furthermore, existing virtual worlds may not be designed for optimal teaching (e.g., integrating quizzes) (Schultze et al., 2008).

ii. Inability to read "natural" physical cues

There has been discontent with not being able to read natural body language. Although an avatar can present certain facial expressions, one professor indicates that these forced expressions are meaningless and doesn't provide sound evidence of a student's attentiveness or boredom (Graves, 2008). Dickey (2005a) also notes that the *traditional* classroom setting provides a broader range of non-verbal communication.

iii. Technological Issues

Technological issues that may arise include proprietary applications with limited adaptability to other contexts as well as system usability (Mantovani, Castelnuovo, Gaggioli, and Riva, 2003). Bryson (1996) cites virtual reality issues that include the re-invention of interfaces that accommodate the three-dimensional versus traditional two-dimensional designs and requiring exceptionally high system performance such that the virtual-reality effect can be experienced. In previous applications of Second Life in education, Schultze et al. (2008) reported that some learners did not have enough hardware power or bandwidth to properly utilize Second Life and most of the discussions were focused on the features of Second Life and not the to-be-learned topic. Dickey (2005a) indicates that in some virtual environments, such as Active Worlds and Adobe Atmosphere, only text communication is available. Also, in Active Worlds, objects can not easily be built or moved while in Adobe Atmosphere the object-building process is time intensive and requires some basic skills before one can become proficient.

iv. Costs

Concerns have also been generated over costs (Dickey, 2005a; Mantovani, Castelnuovo, Gaggioli, and Riva, 2003). Schultze et al. (2008) note that a common concern for *any* implementation of technology in education is costs. Costs may include the purchase of one's own island, but also the cost associated with building and maintaining the island.

v. Behavioral, Health, and Safety Issues

Other issues that may arise include health and safety issues (e.g., simulator sickness, ocular problems) (Mantovani, Castelnuovo, Gaggioli, and Riva, 2003). Also, activities may become more playful than educational, and monitoring behavior can present challenges (Graves, 2008). For example, Ohio University's Second Life campus experienced a virtual shooting and Woodbury University students were engaging in "disruptive and hostile behavior" (Graves, 2008, p. 50). Bugeja (2008) cites that the two most common violations in Second Life are assault and harassment. He indicates that issues may arise when the company's terms of service agreements may conflict with academic due process in cases such as violence, or students are required to agree to these service terms in order to participate in this virtual world. Questions to be considered, as posed by the author, include: Has the professor included warnings if he/she required an exercise to be performed in a virtual world? Is your institution aware of harassment issues in virtual worlds or has issued guidelines on its use?

vi. User Adoption

Lack of experience with using virtual worlds can raise issues for teachers (Dickey, 2005a; Mantovani, Castelnuovo, Gaggioli, and Riva, 2003) as well as students (Dickey, 2005a). For instance, concerns include acquiring the skills to function in a virtual world, such as being able to teleport and master basic communication

(Graves, 2008). As noted by Dickey (2005a), in virtual environments, such as Active Worlds, in which text-only communication is available, those individuals who do not have adequate typing or written language skills may suffer. Virtual worlds have been noted as not scaling well when too many avatars are participating simultaneously (Mennecke et al., 2008). Another issue is trust (Siau & Shen, 2003; Siau et al., 2004). Are the teachers and students going to trust the technology, the environments, and the people that they meet in the environments?

In experiences with conducting a single session class in Second Life, Schultze et al. (2008) indicated that learners (ranging in age from 25 to 50) encountered many problems in navigation, as well as experienced disorientation and confusion. However, a four-week set of sessions with learners who had significant online gaming experience and were averaging 20 years of age indicated that Second Life was simple, but the graphics appeared outdated. In addition, Barab et al. (2000) found that learners spent a significant amount of time learning the software for their 3-D virtual world learning environment, resulting in a delay of exploring the to-be-learned subject matter. They, however, felt that this could have been avoided if they would have used a scaffolding approach in accomplishing technical skills and subject-matter concepts.

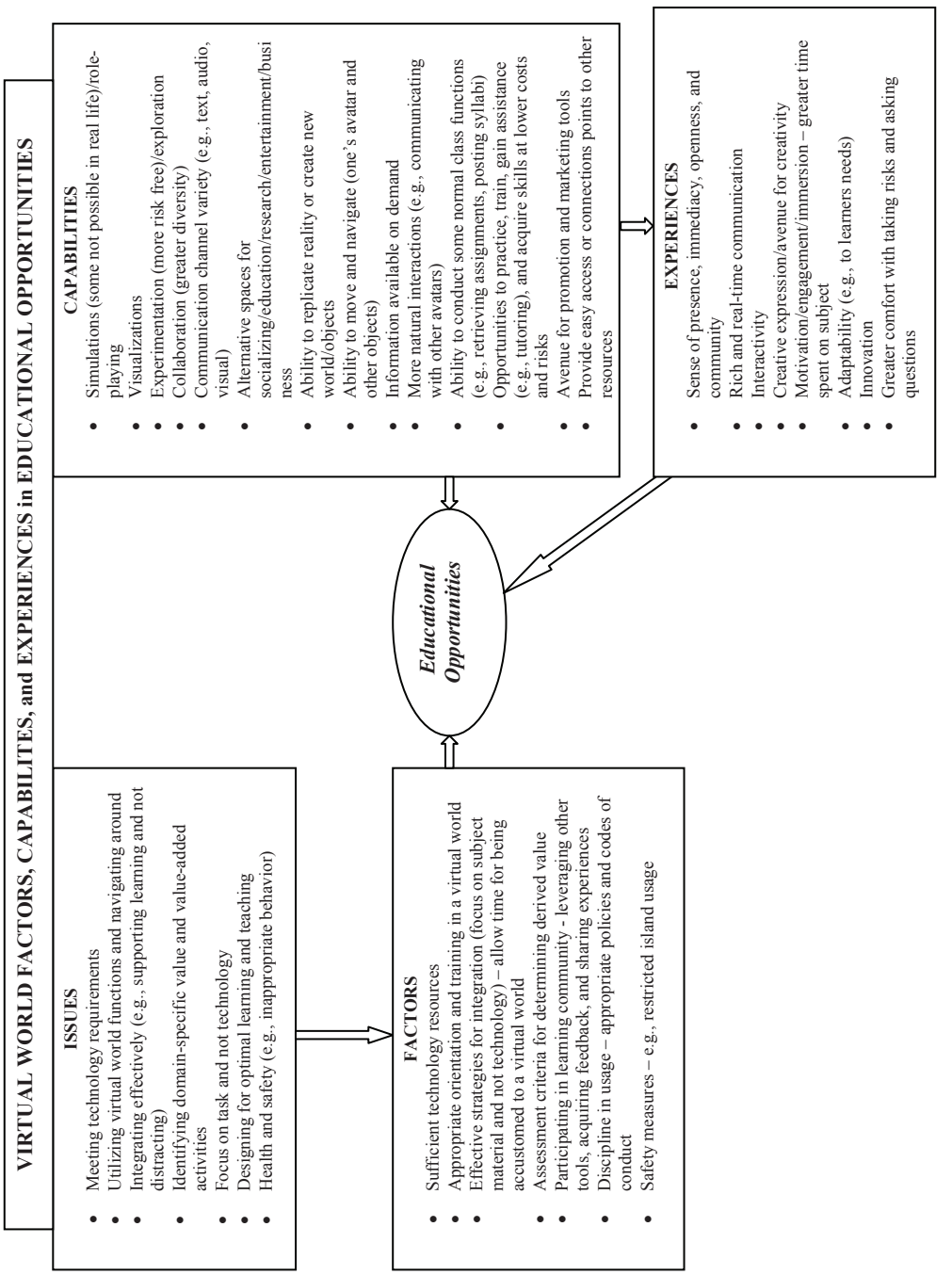
EDUCATIONAL OPPORTUNITIES IN 3-D VIRTUAL WORLDS

Based on the review above, we present Figure 1 which summarizes aspects of 3-D virtual worlds and their implications for educational opportunities. The use of virtual worlds in an educational context generates certain issues as well as affords various capabilities. When considering educational opportunities, certain factors can be considered to address the issues that are inherent. For example, it is important to assure that individuals engaging in 3-D virtual world environments have the appropriate technological requirements, training, orientation, and time to become accustomed to the virtual world so the technology is not distracting to their learning. Also, utilizing assessment criteria for determining the value that can be derived from the use of 3-D virtual world environments in education can help determine "when" and "where" they can be applied. Participating in a learning community in which tools and experiences can be shared to address concerns can help to identify "how" educational value can be derived, such as joining the Second Life education (SLED) listserv to communicate with other educators or browse the Second Life Education Wiki. Appropriate safety measures and disciplinary policies should also be considered to address health and safety concerns.

The 3-D virtual world environments provide many capabilities, including simulations and visualizations, that cannot feasibly take place in reality but can be incorporated in the design of educational opportunities. These capabilities also generate various experiences that can be leveraged as well. For example, the ability to experiment and explore in 3-D virtual world environments can generate educational opportunities that foster innovation. The ability to move one's avatar, communicate through various channels, and conduct more natural interactions can foster rich and real-time communication which can enhance educational activities focused on collaboration. Also, providing opportunities to practice or participate in simulations can generate greater engagement and interactivity.

Hence, educational opportunities in 3-D virtual world environments can be derived through the virtual world's existing capabilities and associated experiences. These opportunities can be enhanced by consideration of various factors that address the associated issues that accompany 3-D virtual world experiences. To appropriately address the potential of 3-D virtual world environments in meeting pedagogical objectives, we compare the capabilities of these environments to a taxonomy of learning objectives to identify the possibilities as well as the gaps that remain, described as follows.

Figure 1. Virtual world implications in education



GAPS IN 3-D VIRTUAL WORLD ENVIRONMENT CAPABILITIES IN EDUCATION

The 3-D virtual world environments have demonstrated potential usage in an educational context, but gaps may remain. To assess the potential as well as the gaps, we compare these capabilities to Fink's (2003) taxonomy of significant learning. Fink identified a need to broaden Bloom's taxonomy of educational objectives considering "individuals and organizations involved in higher education are expressing a need for important kinds of learning that do not emerge easily from the Bloom taxonomy" (p. 29). Therefore, Fink created a new taxonomy that focuses on learning in terms of change. The taxonomy and its relation to 3-D virtual world environments are listed in Table 2.

As noted in Table 2, all but one of Fink's categories of significant learning can potentially be addressed in some regards in 3-D virtual world environments. Learners are able to acquire a foundational knowledge as well as learn its application. Through collaborative, interactive, and cooperative activities, learners can integrate knowledge and understand its social and individuals implications. Also, learners can become more engaged and immersed in an activity, and they can develop a deeper sense of caring for the topic. However, no indications of educational applications in such environments indicate that students become more capable, self-directed learners or have developed strategies (e.g., metacognitive strategies) that imply that they have learned how to learn. Therefore, many educational opportunities exist and much potential for meeting various pedagogical objectives are possible in 3-D virtual world environments. Gaps may remain in the ability for students to "learn how to learn."

IMPLICATIONS

Practical Implications

Various opportunities have arisen and continue to evolve in applying 3-D virtual worlds in the field of education. Examples for business-related courses include:

- **Strategic management:** create competition in which each team manages an existing business or designs a new business that markets a particular product or service. The activities can include conducting research and development, making manufacturing production decisions, establishing prices, and developing advertising campaigns.
- **Operations management:** create simulations of supply chains
- **Management information systems:** create virtual simulation of data and information flowing through an enterprise resource planning system, or a simulation of e-commerce (electronic commerce)/u-commerce (ubiquitous commerce transactions)
- **Management/Leadership:** role playing as a manager training/evaluating/managing employees, facilitate virtual presentations from guest speakers who are geographically dispersed
- **International management:** meeting individuals from across cultures and collaborating with students from other universities on projects
- **Marketing:** role playing sales presentations or advertising strategies, experiment with brand management, create a service enterprise to provide marketing/advertising services to businesses (or other organizations) joining 3-D virtual world environments
- **Finance:** create simulations of actively trading stocks
- **Economics:** study the entire ecosystem within a 3-D virtual world environment that is emerging

The examples given above are a few of the many educational opportunities that exist for business-related courses. Many others exist outside the domain of business as well. Hence, the potential for applications of virtual worlds in any field of education is just starting to be realized and will continue to develop.

Table 2. Fink's (2003) Taxonomy of significant learning – application to 3-D virtual world environments

Category	Description	3-D Virtual Environment Affordances
Foundational Knowledge	Being able to understand and remember – the basic knowledge that is foundational to other learning	Provides ability to acquire information when needed and understand concepts (some too difficult to learn through traditional instruction but possible through 3-D visualizations)
Application	Engaging in other actions or thinking (e.g., critical, creative), acquiring certain skills, and managing complex projects – basis for other learning to be useful	Environment provides creative expression opportunities, ability to practice, and encourages critical thinking and risk-taking
Integration	Identifying and comprehending connections between different ideas, people, or realms – creation of intellectual power	Collaboration and cooperative activities allow connections between people; environment allows viewing creations from multiple perspectives; creating simulations allow opportunities to understand entire dynamic relationships
Human Dimension	Understanding important aspects of one's self or others, includes understanding personal and social implications – derivation of human significance of subject matter	Interactions with others can provide insights into social and personal factors
Caring	Changes in feelings, interests, or values in which the student cares about subject – acquisition of energy needed for learning	Engaging and becoming immersed in a subject can generate increased sense of caring
Learning How to Learn	Learn how to learn: becoming a more successful student, engaging in inquiry, or self-directing learning – support more effective and continuous learning	No immediate application identified; may depend on learning tasks

Therefore, it will be important for instructors to consider all the capabilities and derived experiences that are associated with 3-D virtual worlds (see Figure 1), and consider the pedagogical objectives they want to achieve (see Table 2). These capabilities can be leveraged in various manners to provide new or enhanced educational opportunities. For pedagogical objectives that are focused on innovation, exploration, and risk-taking, an instructor can capitalize on virtual worlds' abilities to provide platforms for prompting these experiences. If practice or training of certain skills is necessary, simulations can be created in virtual worlds to promote such activities. Also, if collaboration is desired, an educator can take advantage of the rich communication media available in 3-D virtual worlds, such as the audio, visual, and textual features of Second Life.

However, instructors will also want to take into account various factors that address issues inherent in a 3-D virtual world environment. Assessing the value that can be derived as well as incorporating appropriate disciplinary measures will be essential for an optimal education experience to be achieved. John Lester (SL: Pathfinder Linden) of Linden Lab suggests the following strategies for success in utilizing Second Life in education (Lester, 2006):

1. Explore and learn about Second Life as much as possible

2. Converse with other educators currently utilizing Second Life
3. Develop concise, measurable goals
4. Write a paper about your Second Life experiences and utilize other venues to share your knowledge.
5. Be open to the potential of Second Life and the variations in activities possible
6. Think creatively about new uses for instruction and avoid applying old models of thinking
7. Capitalize on feedback from students' experiences.

Specific projects are being undertaken to enhance and capitalize on the educational opportunities within 3-D virtual worlds. For example, the SaLamander Project's goal is to "survey, collect, and describe 3D objects, materials, resources, and environments in Second Life created specifically for use in teaching and learning or with the potential to be useful in such activities" (Richter, Anderson-Inman, and Frisbee, 2007, p. 21). Hence, educators will benefit from accessing these developing resources as well as communicating with the existing community of educators in 3-D virtual world environments.

Research Implications

Based on the literature review conducted, researchers will need to be aware of issues that have arisen as well as the experiences and capabilities that are possible in 3-D virtual world environments. For example, 3-D virtual environments require advanced technology resources, appropriate training and orientation before users can be expected to perform specific tasks, and adequate time for users to become familiar with the environment. Also, safety measures may be needed, such as acquiring one's own island so usage is restricted, so that behaviors can be properly monitored.

The capabilities and opportunities that exist in virtual environments provide much potential for insightful research experiments. Research that may not have been practical or feasible in real life can be created through simulations in environments. With abilities to collaborate and a variety of communication channels, researchers can study social behaviors in various contexts. Also, the experiences of creative expression and innovation that are possible in virtual worlds can be studied at an individual level with a variety of tasks.

Various educational institutions are citing plans for future research in 3-D virtual world environments. For example, Louisiana has implemented a statewide initiative to explore the value of virtual world environments for higher education, which includes the purchase and development of five islands in Second Life (Graves, 2008). The Immersive Education project is developing virtual-reality software for Second Life spaces that incorporates Web cameras, Internet-based telephony, three-dimensional graphics that are interactive, as well as other digital media (Foster, 2007a). The ultimate goal is to develop interactive activities that can capture a student's attention similar to gaming environments enticements. Some of the environments being developed have publicly available code (i.e., open source) (see Long and Siau, 2007; Crowston and Scozzi, 2008) allowing others to customize as needed. Other endeavors include developing best practices and open standards. Using Second Life as a laboratory, business professors are exploring it as developmental ground for entrepreneurs (Foster, 2007b).

Mennecke et al. (2008) highlight three broad themes to provide perspectives on future research: psychological, sociological, and technical. The psychological theme encompasses the individual personality, dispositions, and traits that influence a user's experience. Sociological theme recognizes the dynamic interactions of agents (i.e., avatars) and the influence of these on group outcomes and individual experiences. Finally, the technical theme addresses the progression of interweaving existing technologies with virtual worlds and improving functionality. Therefore, future research can expand on Figure 1 to study the influence of specific psychological, social, and technical factors, along with the capabilities and experi-

ences that are possible in 3-D virtual worlds on educational experiences (see Figure 2).

Schultze et al. (2008) suggest that pedagogical techniques need to be explored that promote effective collaboration as well as constructivist learning in 3-D virtual world environments. Junglas, Johnson, Steel, Abraham, and Loughlin (2007) argue that social psychological theories that have been previously applied to understand learning styles in the real world need to be readdressed in the virtual world. Junglas and Steel (2007) indicate that future research can more closely examine variations in the capabilities that 3-D virtual worlds can provide, including visualization, simulation, and social presence. Hence, future research can explore additional applications of 3-D virtual world environments in education.

One method of doing so is to conduct a focus group study or Delphi study of individuals currently utilizing 3-D virtual worlds for teaching and research. Focus sessions can identify criteria for evaluating value-added activities as well as strategies for effectively integrating 3-D virtual worlds into a curriculum. Factors that are associated with adoption of 3-D virtual worlds into educational activities by educators can be explored as well. Also, experiments of various constructivist activities and their effect on learning outcomes can be conducted. The learning experience may vary among individuals; hence, additional research can focus on individual learner profiles that are more likely to capitalize on the learning experience in 3-D virtual worlds.

CONCLUSION

In summary, virtual reality environments present new opportunities for education. The unique opportunities of creating an interactive environment occupied by avatars with advanced communication abilities have opened up new avenues for a variety of educational experiences. This article specifically reviews aspects of 3-D virtual world environments to assess current applications, benefits that are being realized, and issues that have emerged. In the context of educational opportunities, factors, capabilities, and derived experiences in 3-D virtual world environments are identified. The capabilities range from creating simulations and role-playing to collaboration. The derived experiences include a sense of presence as well as promoting innovation to name a few. However, factors to be taken into account for educational opportunities include proper training and orientation, appropriate strategies for integration (Langdon 2006), and criteria for determining value-added activities. Hence, this review provides various practical implications for those interested in exploring educational opportunities in 3-D virtual world environments, as well as provides suggestions for future research. As educational applications of 3-D virtual worlds are beginning to evolve, their true potential and influence on education is yet to be fully explored and discovered.

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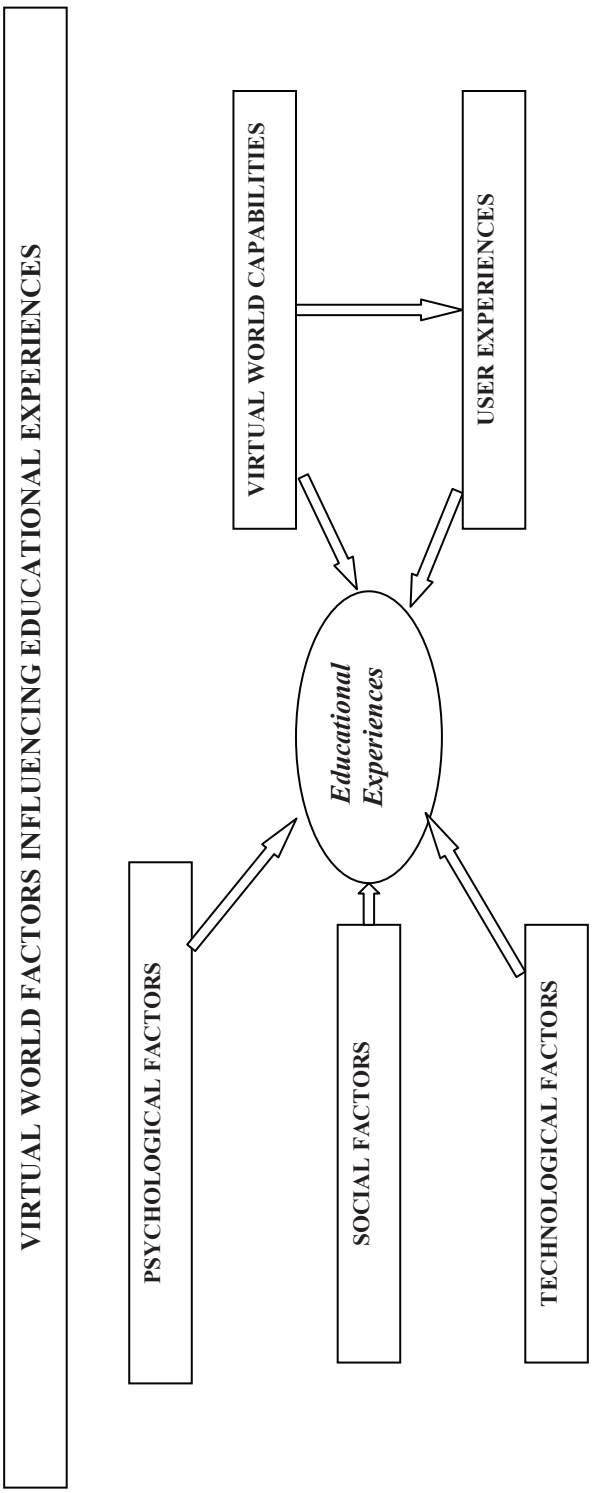
Figure 2. Virtual worlds in education



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